REMARKS

With this Amendment, claims 1-3 are amended, and claims 4 and 8-12 are canceled, such that claims 1-3 and 5-7 remain pending. Reconsideration and review of the claims as amended is respectfully requested.

With this Amendment, the specification is also amended, such that the heading "Summary of the Invention" is moved to be inserted prior to page 2, line 6, and further, at page 2, line 6 of the application, the words "Laid-Open" are deleted. This was a typographical error in the translation. Please note the Japanese Patent Application No. 240691/2000 referred to was actually Laid-Open on February 22, 2002, with Laid-Open No. 58231/2002; this date is **after** the priority date of the present application. Accordingly, the Japanese Patent Application No. 240691/2000 cannot be used as prior art.

This means that it was not publicly known to reduce the cogging torque and the tertiary harmonic contents in the current wave form by arranging the pole teeth provided on the tip ends of the magnetic poles with windings at the vernier pitch wherein the permeance distribution is balanced by the six order harmonic contents with respect to the three-phase hybrid type stepping motor having six magnetic poles with windings.

With respect to the Examiner's comments in paragraph 2 of the Office Action dated June 17, 2003, kindly note that on page 5 of Applicant's Amendment and Response submitted February 18, 2003, was the instruction "Please cancel all paragraphs beginning on Page 10, line 20 through Page 13, line 17."

Further, this application has been amended to correct the inconsistencies noted by the Examiner in paragraph 2 of the Office Action.

Claim 3 has been amended according to the Examiner's suggestion in paragraph 3 of the Office Action and further to recite the limitation "a stator tooth pitch is 7.05" in order to clear up the indefiniteness noted by the Examiner in paragraph 4.

With respect to claim 1, claim 1 is rejected under 35 U.S.C. sec. 103(a) as being unpatentable over what the Examiner has termed "Applicant's admitted prior art" in view of U.S. Pat. No. 6,160,330 to Sakamoto. As discussed above, the Japanese Patent Application No. 240691/2000 is not prior art with respect to this application. Insofar as the Sakamoto reference alone applies to this application, applicant believes that claim 1 is patentable over Sakamoto. Sakamoto does not disclose or suggest a permeance distribution of the small stator teeth is a vernier pitch balanced by a six order harmonic wave. Further in Sakamoto, the optimum value of the ratio of the tooth width of the small stator teeth with respect to the pitch of the small rotor teeth is .333, which is out of the range of 0.35-0.45 recited in claim 1.

The optimum range recited in claim 1 is obtained by a study of the relation of the effective magnetic flux with respect to the ratio of the tooth width to pitch (as defined), cogging torque, and the rate of distortion of the effective magnetic flux, as obtained by the detailed magnetic finite element analysis. The claimed range is therefore not disclosed or suggested in Sakamoto, and claim 1 is allowable.

Similarly, claims 2 and 3 are rejected under 35 U.S.C. sec. 103(a) by the Examiner as being unpatentable over what the Examiner has termed "Applicant's admitted prior art" in view of Harned and further in view of Sakomoto. As previously explained, the Japanese application mentioned in the specification is not prior art with respect to this application. Insofar as this rejection applies to the claims as amended, the rejection is respectfully traversed. Amended claims 2 and 3 are patentable over Sakamoto and Harned because neither reference discloses or suggests a permeance distribution of the small stator teeth is a vernier pitch balanced by a six or a three order harmonic wave.

Further, Harned discloses a motor wherein a third harmonic is introduced (see col. 2, line 36), whereas in claim 2 of the present application, a three order harmonic wave is eliminated or balanced.

With respect to claim 3, further note that in Harned, a stator tooth pitch of 7.05 is not disclosed. Kindly note that in Harned a stator tooth pitch is 360/48 = 7.5.

Claims 5-7 depend respectively from claims 1-3, and are patentable for the reasons stated above.

In view of the foregoing, it is submitted that this application is in condition for allowance. Favorable consideration and prompt allowance of the pending claims are respectfully requested.

The Examiner is invited to telephone the undersigned if the Examiner believes it would be useful to advance prosecution.

Respectfully submitted,

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Nanci A. Musich

IN THE SPECIFICATION

Please move the heading "SUMMARY OF THE INVENTION" immediately before page 2, line 6 and please substitute the following amended paragraph(s) and/or section(s) thereafter:

Japanese Patent Application ~~Laid-Open~~ No. 240691/2000 discloses the reduction of the cogging torque and the tertiary harmonic contents in the current wave form by arranging the pole teeth provided on the tip ends of the magnetic poles with windings at the vernier pitch wherein the permeance distribution is balanced by the six order harmonic contents with respect to the three-phase hybrid type stepping motor having six magnetic poles with windings.

At page 10, lines 15 and 16 of the original application:

As a result of the consideration with respect to the structure of the three-phase hybrid type stepping motor, following results can be obtained.

(1) The magnetic flux in case of the six magnetic poles with windings becomes twice as large as that in case of the twelve magnetic poles with windings, so that the propriety of the multiply of the torque is inspected in this respect.

(2) In the vernier system, six order balance is the best with respect to the cogging torque and the magnetic flux.

(3) ~~The tooth width ratio~~ The ratio of the tooth width with respect to the pitch of about 0.4 of the small teeth is the best, however, the ~~tooth width~~ ratio of 0.41 of the normal motor may be adopted with no problem.

Second amendment to "Summary of the Invention" -- at page 15 of the Amendment and Response to the Office Action dated Oct. 17, 2002:

An object of the present invention is to provide a three-phase hybrid type stepping motor ~~invention comprises~~ **comprising** a stator, and a rotor arranged concentrically with the stator and with an air gap therebetween, said stator having an annular stator yoke, six stator poles extending radially and formed at a regular pitch on the inner peripheral surface of the annular stator yoke, and stator windings of three-phase each wound around each stator pole, each of said stator poles having a plurality of small stator teeth at the tip end thereof, said rotor having two splitted rotor elements and a permanent magnet held therebetween and magnetized so as to form N and S poles in the axial direction thereof, and a plurality of small rotor teeth formed at a regular pitch on the outer peripheral surface of each of said rotor elements, said two splitted rotor elements being shifted from each other in angular position by a ½ pitch of the small rotor teeth. A permeance distribution of the small stator teeth is a vernier pitch balanced by a six order harmonic wave, and a tooth width ratio of the small rotor teeth ~~with~~ **or** the small stator teeth **with respect to the pitch of the small rotor teeth** is set to 0.35 - 0.45.

Another object of the present invention is to provide a three-phase hybrid type stepping motor wherein a permeance distribution of the small stator teeth is a vernier pitch balanced by a three order harmonic wave, and a ratio of tooth width ~~ratio~~ of the small rotor teeth ~~with~~ **or** the small stator teeth **with respect to the pitch of the small rotor teeth** is set to 0.35 – 0.45.

A further object of the present invention is to provide a three-phase hybrid type stepping motor, wherein a number of the small rotor teeth is fifty, a number of the small stator teeth is eight, a tooth pitch is 7.05, and a ratio of tooth width ~~ratio~~ of the small rotor teeth ~~with~~ **or** the small stator teeth **with respect to the pitch of the small rotor teeth** is set to 0.35 – 0.45.

IN THE CLAIMS:

1. (currently amended): In a three-phase hybrid type stepping motor comprising a stator, and a rotor arranged concentrically with the stator and with an air gap therebetween, said stator having an annular stator yoke, six stator poles extending radially and formed at a regular pitch on the inner peripheral surface of the annular stator yoke, and stator windings of three-phase each wound around each stator pole, each of said stator poles having a plurality of small stator teeth at the tip end thereof, said rotor having two splitted rotor elements and a permanent magnet held therebetween and magnetized so as to form N and S poles in the axial direction thereof, and a plurality of small rotor teeth formed at a regular pitch on the outer peripheral surface of each of said rotor elements, said two splitted rotor elements being shifted from each other in angular position by a 1/2 pitch of the small rotor teeth, a permeance distribution of the small stator teeth is a vernier pitch balanced by a six order harmonic wave, and a ratio of the tooth width of the small rotor teeth or the tooth width of the small stator teeth with respect to the pitch of the small rotor teeth is set to .35-.45.

2. (currently amended): In a three-phase hybrid type stepping motor comprising a stator, and a rotor arranged concentrically with the stator and with an air gap therebetween, said stator having an annular stator yoke, six stator poles extending radially and formed at a regular pitch on the inner peripheral surface of the annular stator yoke, and stator windings of three-phase each wound around each stator pole, each of said stator poles having a plurality of small stator teeth at the tip end thereof, said rotor having two splitted rotor elements and a permanent magnet held therebetween and magnetized so as to form N and S poles in the axial direction thereof, and a plurality of small rotor teeth formed at a regular pitch on the outer peripheral surface of each of said rotor elements, said two splitted rotor elements being shifted from each other in angular position by a ½ pitch of the small rotor teeth, a permeance distribution of the small stator teeth is a vernier pitch balanced by a three order harmonic wave, and a ratio of the tooth width of the small rotor teeth or the tooth width of the small stator teeth with respect to the pitch of the small rotor teeth is set to 0.35-0.45.

3. (currently amended): The three-phase hybrid type stepping motor as claimed in Claim 1, wherein a number of the small rotor teeth is fifty, a number of the small stator teeth is eight, a stator tooth pitch is 7.05, and a ratio of the tooth width ~~ratio~~ of the small rotor teeth or the tooth width of the small stator teeth with respect to the pitch of the small rotor teeth ~~with the small stator teeth~~ is set to 0.35-0.45.

4. (canceled)

5. (original): The three-phase hybrid type stepping motor as claimed in Claim 1, wherein the three-phase windings of the stator are connected in the form of delta.

6. (original): The three-phase hybrid type stepping motor as claimed in Claim 2, wherein the three-phase windings of the stator are connected in the form of delta.

7. (original): The three-phase hybrid type stepping motor as claimed in Claim 3, wherein the three-phase windings of the stator are connected in the form of delta.

8-12 (canceled)